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㊴発明の名称　全閉形回転電気機械の冷却装置

㉑特　　願　昭59－17833

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明　細　書

1. 発明の名称

全閉形回転電気機械の冷却装置

2. 特許請求の範囲

フレームと、このフレームの内周側に装着された冷却器と、前記フレームの内周側に支持物を介して取付けられた固定子と、上記フレームに回転自在に支承され、所定部に冷却ファンが固着された回転子を備え、機内に冷却媒体を封入して上記冷却ファンにより上記冷却器を介して内気を循環させ、冷却を行うようにした全閉形回転電気機械の冷却装置において、上記冷却媒体として、空気とヘリウムの混合ガスを封入すると共に、上記ヘリウムの容積比を40～90%の割合とし、かつ上記フレーム内の密封度を上記容積比が維持され得るように構成したことを特徴とする全閉形回転電気機械の冷却装置。

3. 発明の詳細な説明

〔発明の技術分野〕

この発明は、例えばタービン発電機等全閉形回転電気機械の冷却装置に関するものである。

〔従来技術〕

従来のこの種の回転電気機械の冷却装置として一般に知られている全閉内冷形のタービン発電機を第1図に示す。

図において、(1)はフレームで、その内周側に複数個の冷却器(2)が装着されている。(3)はフレームの内周に支持物(4)を介して取付けられた固定子、(5)は上記フレーム(1)に軸受(7)によって回転自在に支承された回転子で、その所定部には冷却ファン(6)が設けられている。(8)は機内に封入された冷却媒体でこの場合は空気である。

次に動作について説明する。冷却器(2)によって冷却された空気は冷却ファン(6)によって駆動され、回転子(5)、回転子(5)と固定子(3)間の空隙、固定子(3)中央部の後方へ流入する。そして、回転子(5)、固定子(3)を冷却し、温度上昇をして最終的に冷却器(2)へ導かれる。

風損は固定子(3)、回転子(5)を冷却するための空気の駆動損、回転子(5)のファン作用による損

Publication of Unexamined Patent Application (A):
SHO 60-162432 (1985-162432)

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Title of the Invention: A Cooling Device for a Totally-enclosed Rotating Electrical Machinery

Filing No.: SHO 59-17833

Date of Application: February 1, 1984

Inventor: Yasuo Takai, Shigekazu Sakabe

Applicant: Mitsubishi Electric Corporation

Specification

1. Title of the Invention

A Cooling Device for a Totally-enclosed Rotating Electrical Machinery

2. Claims

A cooling device for a totally-enclosed rotating electrical machinery comprising a frame, a cooler installed inner-periphery of said frame, a stator installed inner-periphery of said frame by a support, a rotor rotatively supported on said frame and having a cooling fan thereon, and a cooling mechanism that cools inside the machinery with circulation of an interior-gas by said cooling fan through said cooler using a coolant sealed therein; wherein said coolant is a mixed gas of air and helium with the mixing ratio of 40% to 90% in helium volume content, and a sealing degree inside said frame is composed so that said volume content maintains said mixing ratio.

3. Detailed Description of the Invention

[Field of the Invention]

The present invention relates to a cooling device for a totally-enclosed rotating electrical machinery such as a turbine generator.

[Prior Art]

Fig. 1 shows a turbine generator of the totally-enclosed internal-cooled type that has been generally known as one of

cooling devices for rotating electrical machinery of this type.

In the figure, the numeral (1) denotes a frame, on the inner-periphery thereof, a plurality of coolers (2) are installed. The numeral (3) denotes a stator installed on the inner-periphery of a frame with a support (4), and (5) a rotor rotatively supported on said frame (1) by a bearing (7) wherein a fan (6) is installed on said rotor (5) at a designated position. The numeral (8) denotes a coolant, an air in this art, sealed in the machinery.

The explanation now enters in the working effects. The air cooled in the cooler (2) is driven by the cooling fan (6) and flows into the space among the rotor (5), the gap between the rotor (5) and the stator (3), and the rear-middle of the stator (3). The air then is guided finally to the cooler (2) cooling the rotor (5) and stator (3) being given a temperature rise.

Windage loss includes the driving loss of said air to cool the stator (3) and the rotor (5), the loss attributable to a fanning effect of the rotor (5), and the frictional loss that a rotating object may invite. This windage loss occupies a greater portion of the total loss as those losses have been so in rotating electrical machinery those run at high speed.

The arrows in the illustration show the direction of coolant flow.

For the case that the coolant is an air like in the above, the higher the rotating speed becomes the greater the windage loss increases because of the specific gravity of the coolant used. This causes difficulty in small-sizing and in improving efficiency. Further, because of its exploding nature, use of hydrogen as the coolant requires a high-purity gas monitor, sealing device, and explosive structure. The use of hydrogen

moreover invites a problem that a long time is necessary in replacement of the coolant to avoid mixing with air.

[Brief Description of Invention]

The present invention is endeavored to eliminate problems in the prior arts as mentioned above. The object of the invention is to provide a high efficiency cooling device having a high performance for a rotating electrical machinery by using a mixture of air and helium, a lighter specific gravity than air and non-explosive, as the coolant being given an optimum mixing ratio.

[Preferred Embodiment]

The following explains one of embodiments of the present invention.

In Fig. 2, the numeral (9) denotes a coolant sealed in the machinery, that is a mixed gas of air and helium. Therefore, a frame (1) is properly sealed at every sealing-requiring portion thereof for a higher degree of sealing performance than that in the conventional electrical machinery that use air as their coolant so that volume ratio of air and helium can be maintained.

Details for other particulars in this embodiment are omitted since they are the same as those in the conventional machinery.

Explanation follows for the air-helium mixture coolant comparing with air coolant. The windage loss is usually proportional to the specific gravity. Therefore, larger volume occupation by helium in the mixture reduces the windage loss more as shown in Fig. 3. On the other hand, the larger volume of helium increases thermal conductivity and the dynamic viscosity coefficient as shown in Figs. 4 and 5. The heat transfer rate α is proportional to Reynolds Number ($R_e = U \cdot L/N$,

U: velocity, L: characteristic length, N: dynamic viscosity coefficient) to the 0.8 power. Therefore, the heat transfer rate of the air-helium coolant shows its peak in a range of 60 to 70 % of helium content as shown in Fig. 6 when the coolant composition is varied from air-only to air-helium mixture maintaining other conditions unchanged. Hence, the heat transfer rate reaches about 1.6 time of that of air only.

The windage loss under this transfer rate is reduced by 50 to 60 % because of its specific gravity. When the reduction of the windage loss is the only purpose, the coolant may use helium alone. However, the use of helium alone causes lower discharging performance depending on the helium volume content as an experiment shown in Fig. 7 tells; a poor discharging performance when helium only. This means that the coolant with a helium content of 40 to 90 % by volume provides the most preferable low windage loss and high heat transfer rate.

Further, helium is an inert gas, that may bring a long life in the insulation of the machinery.

Moreover, a rotating electrical machinery that is cooled with air-coolant is applicable to this cooling device without structural change since such mixed gas is used at atmospheric pressure.

Although the above-mentioned embodiment uses the mixed gas under atmospheric pressure, use of pressurized coolant would contribute further small-sizing in the cooler because pressurization makes the coolant have high Reynolds Number, high heat transfer rate, and high specific gravity.

[Effect of the Invention]

According to the present invention as described above, a mixed gas of air and helium with an optimum mixing ratio is used

as the sealed coolant for a totally-enclosed rotating electrical machinery, therefore, the windage loss is largely reduced and heat transfer ratio is improved to lower the coil temperature that influences the performance of a rotating electrical machinery achieving machinery's size reduction.

4. Brief Description of the Drawings

Fig. 1 is a view of the drafting structure in a conventional rotating electrical machinery. Fig. 2 is a view of the drafting structure in the rotating electrical machinery as an embodiment of the present invention. Fig. 3 is a diagram that shows a relationship between the helium volume ratio and the specific gravity ratio to air. Fig. 4 is a diagram that shows a relationship between the helium volume ratio and thermal conductivity ratio to air. Fig. 5 is a diagram that shows a relationship between the helium volume ratio and the dynamic viscosity coefficient ratio to air. Fig. 6 is a diagram that shows a relationship between the helium volume ratio and the heat transfer rate ratio to air. Fig. 7 is a diagram that shows a relationship between the helium volume ratio and the direct current discharging characteristics.

(1): a frame, (2): a cooler, (3): a stator, (4): a support, (5): rotor, (6): a cooling fan, (7): a bearing, (8): a coolant of air-helium mixture.

In the figures, the same numerals indicate the same elements of the equivalents.

Amendment (Voluntary)

Date: March 7, 1985

Addressed to: Commissioner

1. Subject

Filing No. SHO 59-17833

2. Title of the Invention

A Cooling Device for a Totally-enclosed Rotating Electrical Machinery

3. Amender

Relationship to the Subject: Applicant

Address: Marunouchi 2-2-3, Chiyoda-ku, Tokyo

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4. Attorney

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Name: Masuo Ohiwa, in the Capacity of Patent Attorney

5. Description to be Amendment

Columns for Detailed Description of the Invention and related Drawings in the)

6. Details of Amendment

(1) We amend Fig. 7 as attached.

(2) We amend the Specification as below listed.

Page	Line	Before amendment	After amendment
3	10	explosive structure	blast-resistant

			structure
5	2	to the 0.8 power	to about 0.8 power
6	1	without structural change	without large change in structure

(End of Amendment)

Fig. 1

第 1 図

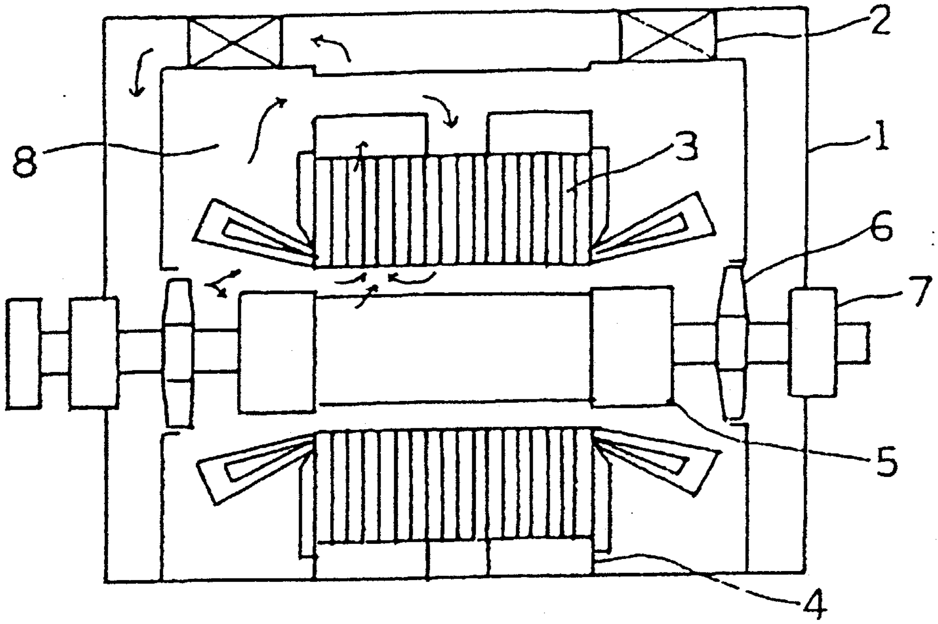


Fig. 2

第 2 図

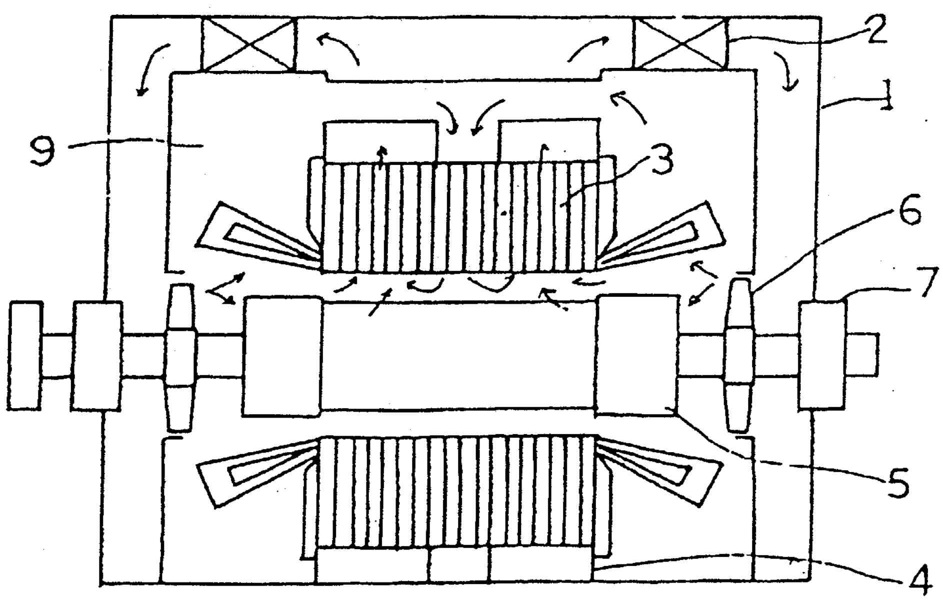
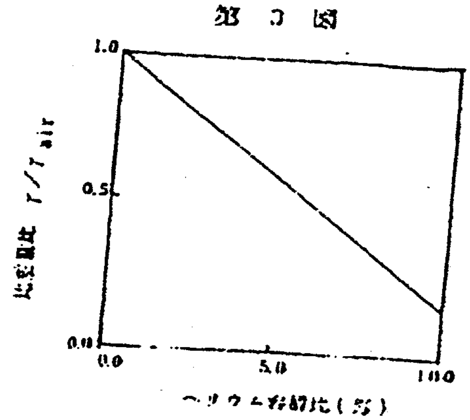


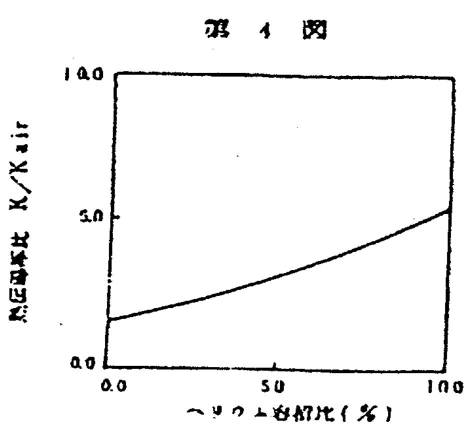
Fig. 3



Specific Gravity

Helium Volume Rate

Fig. 4

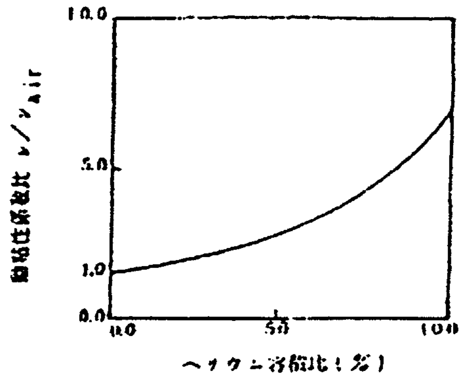


Thermal Conductivity Coefficient

Helium Volume Rate

Fig. 5

第 5 図

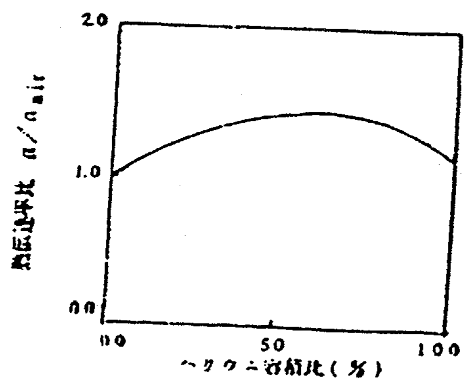


Dynamic Viscosity Coefficient

Helium Volume Rate

Fig. 6

第 6 図



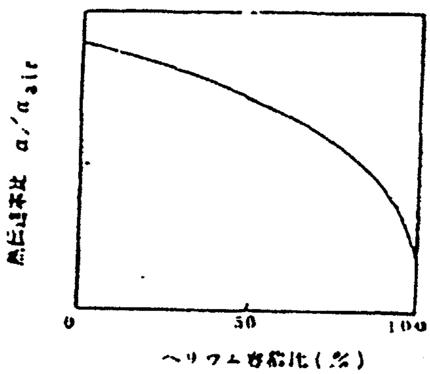
Thermal Conductivity Coefficient

Helium Volume Rate

Fig. 7

第 7 図

Thermal Conductivity Coefficient

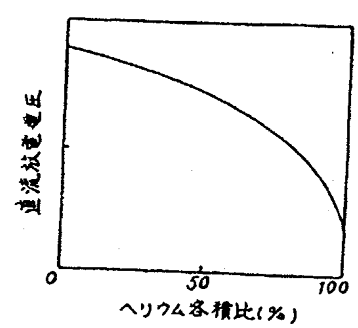


Helium Volume Rate

Fig. 7

第 7 図

Direct Current Discharge Voltage



Helium Volume Rate